Q Method and the Assessment of Student Learning.

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Q方法論と学生の学習評価

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Abstract

This research evaluates Q method as a means of measuring student achievement and teaching effectiveness. Commonly used quantitative measures of student learning such as true-false questions or multiple-choice questions test students' knowledge of individual pieces of information. Essay questions and other techniques can provide a more holistic understanding, but are difficult to quantify, and maintaining consistency across a large number of exams can be a challenge. This paper argues that a modified version of Q method can provide a useful technique to evaluate students' holistic understanding of course concepts. Q method was originally developed in the 1930s in psychology as a means to understand subjectivity, but it has since been applied to a wide variety of research contexts. The modification of the standard Q method process provides information not only on the performance of individual students, but also on the students' ability as a group to comprehend specific course concepts. An example application is presented to illustrate the utility of this modification of Q method as a tool to assess student learning.

Key words: Q method, student assessment, centroid factor analysis

要　旨

このリサーチは、学生の学習成果と教育効果を測る手段としてのQ方法論について、検証を行うものである。一般的に、各学生の学習成果を測るために、選択問題や正誤問題といった試験が行われる。論述式問題は、より包括的な理解力を測ることは可能であるが、定量化することが困難であり数多くある解答で一貫性を持たせることは容易なことではない。本稿は授業内容についての個々の学生の全体理解度を評価するうえで、修正版Q方法論が有効でありうることを論じている。Q方法論は、元は心理学分野において1930年代に始まり、その後様々な分野で幅広く応用されてきた。この修正版Q方法論は個々の学生のパフォーマンスだけでなく、学生グループ全体の理解力を評価することができる。ケーススタディでは、学生の学習評価のツールとして用いる修正版Q方法論の有用性を示している。

キーワード：Q方法論、学生の学習評価、セントロイド因子行

1. Introduction

Teaching practices are rapidly changing as instructors shift to a focus on critical thinking skills and as the advancement of instructional technologies continues. Accordingly, there is a need for assessment tools suited to the new instructional environments arising from these changes. Traditional assessment tools, such as multiple choice questions or true/false questions are still commonly used, but these types of questions assess isolated pieces of student knowledge and therefore make it difficult to evaluate critical thinking skills. While essay questions, concept maps, oral presentations, or portfolios can be used to get a more overall sense of the students' comprehension of course concepts, they can be difficult to grade consistently (particularly in a large enrollment class). It may also be difficult for the instructor to identify patterns of misunderstanding across a large number of students so that adjustments can be made to the design of the course.

This paper explores the possibility of a new type of assessment technique that is based on a modification of Q_method (also occasionally referred to as "Q_sort", or "Q_methodology"). The modification is relatively simple, but it opens up a number of interesting opportunities for assessing students' abilities to understand concepts in a holistic fashion. In general terms this technique can enable the evaluation of students based on their ability to make connections between course concepts, and on their ability to group those course concepts which are similar. In addition, they can be evaluated in terms of their ability to identify important differences between sets of concepts.

The Q_method technique was originally developed by William Stephenson in 1935, and has been actively developed since then into a way of researching attitudes, subjective perceptions, or patterns of thought (Hurd and Brown, 2004/2005). It has been adopted for use within a variety of disciplinary contexts, including environmental research (Barry and Proops, 1999; Ray, 2011), marketing (Davis and Michelle, 2011), and human geography (Robbins, 2000). Despite the spread of Q_method beyond psychology, however, it remains a relatively unknown and underutilized technique.

2. Q_Method Background

The Q_method technique was developed by Stephenson in response to his dissatisfaction with atomistic forms of testing that had dominated psychology at the time (Watts and Stenner, 2005). Q_method flipped the central focus of research from measuring across variables to focusing on *people* (in other words, the research participants) as the variables in the study and measuring the variations in their perceptions. By doing so Stephenson was able to develop a technique with the ability to bring "holistic patterns" into light rather than forcing *a priori* meanings onto the analysis of perception and subjectivity (Capdevila and Lazard, 2007/2008: 71). Thus the research process

for Q method is quite different from that of typical survey research, and requires considerable preparation by the researcher. In the most common use of Q method the research process is composed of three steps - the creation of a concourse of statements, the Q sorts of the statements by the research participants, and the analysis of the commonalities amongst the participants' Q sorts using factor analysis.

Creation of the statement concourse

The first step for Q method research is to make decisions regarding the "domain of subjectivity" (Robbins and Krueger, 2000: 638). In other words, to develop the concourse of statements that will be used in the Q study. The statements can be developed from previous interviews, or can be created by the researcher in a fashion that represents a variety of theoretical positions or ideas related to the topic of interest. The number of statements is also an important consideration. While there is no set upper limit to the number of statements that can be used for a Q method analysis, as a practical concern more than about 60 statements would make it very difficult for the participants to evaluate and physically sort the statements.

Q sorts

After the statement concourse is set, the next step in the Q method process is for the participants to rank order the statements according to a pre-determined forced distribution pattern, usually called a 'Q sort'. During this part of the process the statements are written on small note cards, and the participants arrange them according to their perceptions of the statements. The pattern commonly often takes the shape of a quasi-normal distribution similar to the one seen in Figure 1. There is, however, an ongoing debate regarding the necessity of having a quasi-normal distribution as the shape of the pattern. While Brown (1980) argues that there is no requirement for the researcher to adopt a quasi-normal distribution shape for the Q sorts, while others, such as Block (2008), argue that a normal distribution is required for proper statistical analysis.

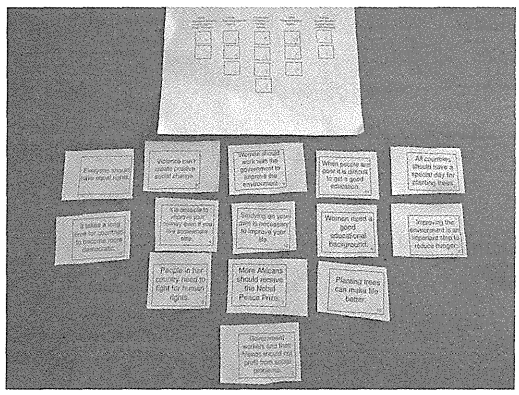

Figure 1. A typical Q sort

Most Q method studies have followed Brown's (1980) lead and use a quasi-normal distribution in which the right side of the distribution is for statements for which the participants have positive feelings or general agreement, and the left side of the distribution is for statements which the participants have negative feelings or general disagreement. Statements located near the left and right edges of the distribution thus represent stronger feelings, in a fashion similar to the Likert scale used in questionnaire surveys. The vertical ordering of the statements is unimportant and has no effect on the outcome of the analysis. Once the participant has arranged all of the statements according to their perceptions, the positions of the statements are recorded for use in the factor analysis.

Factor analysis of Q sorts

After all of the respondents have completed their Q sorts the data is usually analyzed in a specialized software package designed specifically for Q method analysis. The most commonly used software is PQMethod, which is developed and maintained by Peter Schmolck (2002). During the analysis process, the researcher has a variety of decisions to make regarding the way in which the data is analyzed. One of the most important decisions is whether to use principle components analysis or centroid factor analysis to identify the commonalities between the respondents' Q sorts. Centroid factor analysis remains the preferred choice for Brown (1980) and many other proponents of Q method. Another set of decisions must also be made in relation to the rotation of the factors (which express the commonalities amongst the Q sorts) in order to clarify the differences between them. In a Q method analysis each significant factor identified is seen as representing the viewpoint of a group of respondents, so by modifying the rotation method it is possible to explore subtle nuances in the differences between the viewpoints. A more detailed discussion of rotation in factor analysis is beyond the scope of this article, but Brown (1980) and Watts and Stenner (2012) have discussed the issue in detail.

In addition to the identification of factors (viewpoints), the factor analysis output from the PQMethod software also includes synthetic Q sort arrays of the each factor. These are essentially a combined sort of the significant individual Q sorts associated with each factor. The synthetic arrays make it easier to understand how the different understandings of the respondents are expressed in the factors identified by the analysis (Robbins and Krueger, 2000).

3. An Example Application of Q method for the Assessment of Student Learning

To illustrate the changes proposed to Q method for use as an instructional assessment technique, an example from a listening skills class is presented. In contrast to a typical Q method analysis in which the focus is on identifying emergent viewpoints and perspectives, in this example the students were evaluated in relation to a grading key Q sort developed by the instructor before the class. The lesson for the example was based on a chapter from a listening skills textbook

Table 1. The Q sort statements and their expected placement

(+2) Core statements of Wangari Maathai's Philosophy
- Improving the environment is an important step to reduce hunger.
- Planting trees can make life better.

(+1) Statements associated with Wangari Maathai
- Government workers and their friends should not profit from social problems.
- Women should work with the government to improve the environment.
- All countries should have a special day for planting trees.

(0) Statements not associated with either Menchu or Masaai
- Women need a good educational background.
- More Africans should receive the Nobel Peace Prize.
- It takes a long time for countries to become more democratic.
- When people are poor, it is difficult to get a good education.

(-1) Statements associated with Rigoberta Menchu
- It is possible to improve your country even if you live somewhere else.
- People in her country need to fight for human rights.
- Studying on your own is necessary to improve your life.

(-2) Core statements of Rigoberta Menchu's Philosophy
- Violence can't create positive social change.
- Everyone should have equal rights.

(Merdinger and Barton, 2009) which described the life experiences and philosophies of political activists Wangari Maathai and Rigoberta Menchu. After a short lecture by the instructor on the life stories of the activists, the students completed several reading, speaking, and listening exercises. Then, the students were asked to take a short true-false quiz. Immediately after the quiz, the students were asked to volunteer for participation in the Q method exercise. Twenty of the twenty-one students in the class agreed to participate.

The students were assessed according to their ability to differentiate the Q sort statements in three ways. First, they had to differentiate between statements that had some connection to the class exercises and those which did not. Second, they had to differentiate the statements in relation to the differing views and experiences of the two political activists that were the topic of the class. Finally, they had to differentiate between the main ideas of each activist and ideas that were related to each activist, but were not part of their main conceptual position.

The 14 Q statements and their expected placement in the grading key Q sort can be seen in Table 1. The key Q sort included two statements that represented the core philosophy and thinking of Wangari Maathai, and two statements that represented the core message of Rigoberta Menchu. In addition, there were also three statements that represented ideas or events related to Maathai's life or ideas and three statements that represented ideas or events related to Menchu's

Table 2. True/False quiz and Q_sort correlation scores for individual students

	T/F	Q_sort
Student 1	67	73
Student 2	56	77
Student 3	78	77
Student 4	78	82
Student 5	33	73
Student 6	33	14
Student 7	56	73
Student 8	44	50
Student 9	67	77
Student 10	44	86
Student 11	56	82
Student 12	56	82
Student 13	67	77
Student 14	89	73
Student 15	67	64
Student 16	78	45
Student 17	67	82
Student 18	89	86
Student 19	56	59
Student 20	78	86

life. The remaining four statements were not directly related to the exercises on Maathai and Menchu conducted during the class session. The Q_sort key was arranged so that the two core messages of each activist were situated at the ends of the distribution (with values +2 and -2). Next to them were the three related statements for each activist (values of +1 and −1). In the center of the distribution were the four unrelated statements (value 0).

The most appropriate results for the assessment of individual student performance in this technique are the Q_sort correlation scores, which were calculated in relation to the grading key Q_sort developed by the instructor. The correlation score thus represents each individual student's ability to correctly categorize the statements in the three ways discussed above—between those related to the class session and those not related, between those associated with each activist, and between those statements which were main ideas and those which were not. In other words, the correlations scores are a useful measure of the student's ability to understand the course material in a holistic fashion.

Table 3. Factor 1 synthetic array representing the perceptions of a group of 6 students (incorrectly placed statements in italics with correct placement value at the end)

(+2) Core statements of Wangari Maathai's Philosophy

- *Government workers and their friends should not profit from social problems.* (+1)
- Planting trees can make life better.

(+1) Statements associated with Wangari Maathai's Thinking

- *Improving the environment is an important step to reduce hunger.* (+2)
- Women should work with the government to improve the environment.
- All countries should have a special day for planting trees.

(0) Statements not substantially associated with either Menchu or Maathai

- Women need a good educational background.
- When people are poor, it is difficult to get a good education.
- *It is possible to improve your country even if you live somewhere else.* (−1)
- *Studying on your own is necessary to improve your life.* (−1)

(−1) Statements associated with Rigoberta Menchu's Thinking

- People in her country need to fight for human rights.
- *More Africans should receive the Nobel Peace Prize.* (0)
- *Violence can't create positive social change.* (−2)

(−2) Core statements of Rigoberta Menchu's Philosophy

- Everyone should have equal rights.
- *It takes a long time for countries to become more democratic.* (0)

The correlation scores for this example suggest that most students had a reasonably good understanding of the life experiences and thinking of the two activists. Seven of the students had correlation scores above 80% and eight of the students had scores between 70% and 80% (Table 2). There was, however, a group of five students with a much worse understanding of the class material, including one student with a particularly poor correlation score of only 14%. While they should not be directly compared, it is, nevertheless, interesting to examine the variations between the Q-sort correlation scores and the true-false quiz results. In total twelve students had higher correlation scores than true-false quiz results, five students had correlation scores that were generally similar to their true-false quiz scores, and three students had Q sort correlation scores that were worse than their true-false quiz scores. The generally higher Q sort correlation scores relative to the true-false quiz results might have resulted from the longer time that the students spent on the Q method exercise due to the physical nature of the sorting process. In contrast, lower Q sort correlations might have resulted from a failure to take the Q method exercise seriously. It is also possible, however, that students who were able to correctly guess many of the answers on the true-false quiz, may have been unable to guess the correct positions of the statements on the Q sort.

Table 4. Synthetic array values for the three factors

Statements	Synthetic Array Value			
	Key	Factor 1	Factor 2	Factor 3
Everyone should have equal rights.	-2	-2	-2	-2
People in her country need to fight for human rights.	-1	-1	-1	-1
Women should work with the government to improve the environment.	1	1	1	1
Planting trees can make life better.	2	2	2	2
When people are poor, it is difficult to get a good education.	0	0	0	0
More Africans should receive the Nobel Peace Prize.	0	-1	0	0
It takes a long time for countries to become more democratic.	0	-2	0	0
All countries should have a special day for planting trees.	1	1	1	2
Improving the environment is an important step to reduce hunger.	2	1	2	1
Government workers and their friends should not profit from social problems.	1	2	1	-1
Women need a good educational background.	0	0	-1	1
Violence can't create positive social change.	-2	-1	-1	-2
Studying on your own is necessary to improve your life.	-1	0	-2	-1
It is possible to improve your country even if you live somewhere else.	-1	0	0	0

While the correlation scores alone give quite useful information for assessment, the Q_method analysis also provides further insight into the specific understandings of individual students, and also information on the commonalities of misunderstanding that the students may have. This information comes from the centroid factor analysis of the students' correlation scores. In this part of the analysis, the instructor's key Q_sort is removed, and a centroid factor analysis is conducted on the students' Q_sorts. Next, the factors that are identified as significant can be rotated using a varimax rotation procedure to maximize the statistical differences between them.

In the Maathai-Menchu example presented here, the centroid factor analysis identified three significant factors. The synthetic array of Q-sort statements associated with the first factor identified a group of six students (Students 1, 2, 3, 8, 19, and 20) who can be characterized as being somewhat confused about the core messages of Maathai and Menchu, as well as being confused about the statements of Rigoberta Menchu's related ideas (Table 3). The factor two synthetic array characterized seven students as understanding Wangari Maathai's core messages and related ideas very well, but being quite confused about Rigoberta Menchu's core message and related ideas. The third factor was comprised of the Q_sorts of only three students, and its synthetic array suggested that while they can be characterized as having a good understanding of Rigoberta

Menchu's core messages, they had difficulties with the core statements and related ideas of Wangari Maathai.

In addition to identifying synthetic arrays of the Q sort statements it is also possible to examine the statements according to how well students placed them across the three synthetic arrays. By viewing the statements in this fashion, the instructor is able to quickly identify those statements which the students seem to have understood well, and those which they struggled to understand. In this example, the results suggest that students were able to easily understand five statements, all of which were correctly placed in each of the three synthetic arrays (Table 4). Three other statements were correctly placed in two of the three arrays, while five others were correctly placed in only one factor's synthetic array. One statement seemed to be misunderstood by most of the students and was incorrectly placed in all three factors' synthetic arrays.

4. Conclusion

The results suggest that the modification of Q method used in this paper can be quite useful as an assessment technique and that it can provide a unique way for instructors to evaluate student performance in a classroom environment that emphasizes critical thinking skills. Its strength lies in its ability to assess student comprehension of the interrelationship of the concepts addressed in the class in a holistic fashion and with its greater consistency than evaluations based on other techniques such as oral presentations or essay questions. In addition, with little extra effort, the technique simultaneously provides valuable information in relation to understandings of specific concepts across students that can be used by the instructor to improve the design of the course.

There are three issues, however, that could hinder the widespread adoption of this technique. The first issue is the likely unfamiliarity of many instructors with the concepts and terminology of factor analysis, which might make the rotation and the interpretation of the factors a daunting task. A second issue is related to the time and space requirements needed to conduct a Q method analysis. The technique requires considerable preparation time for the instructor to prepare the statement cards, and class time for the students to complete the Q sorts. The physical classroom requirements of doing a Q sort could also create problems. Classrooms with limited student desk space would make Q sorts with a large number of statements difficult. The final issue is the inadequacy of the software most commonly used for Q method analysis. While there are commercial software packages available for Q method, they tend to be relatively expensive. The free software available for Q method (PQMethod) is an outdated MS-DOS package that is difficult to install on most modern computers and lacks a graphical user interface.

Some of these issues could be resolved if a software package to conduct Q sorts on tablet computers was developed. The touch-based focus of tablet computers is particularly suited to the physical process of sorting statements in Q method. Such software would also dramatically reduce the time needed by instructors for preparation and analysis. The development of such software

would greatly facilitate the adoption of Q method and also create new possibilities for further research into Q method as a tool to assess student learning.

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